**Newton’s Laws Summary Sheet**

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| **What is a Force?** | | **Newton’s Three Laws** | |
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| **Newton’s Gravitational Force** | | | |
| G = 6.67259 x 10-11 N\*m2/kg2   1. Gravitational force is always an attractive force 2. Both objects experience the **same magnitude** of force 3. Weight is the gravitational force that the earth exerts on an object. W = mg where m = mass (kg), g = 9.81 m/s2 | | |  |
| **Normal Force** | **Friction Force** | | |
| 1. The normal force FN is the force exerted on an object by a surface in contact with the object. |  | | |
| **Tension Forces and Pulleys** | | | |
| 1. **Tension force** in a rope does not change; the same tension force is in all parts of the rope. 2. **Pulleys**:    1. Changes the direction but not the magnitude of a tension force in a rope.    2. **Multiple pulleys**:       1. Provide mechanical advantage by decreasing the force required to lift.       2. In return for a lower lifting force, the rope must be pulled further than the object moves. |  | | |

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| **Applying Newton’s Laws** | |
| **General Procedure**   1. Draw a picture of the event 2. Define a coordinate system (x-y) 3. Draw a free body diagram to show all forces acting on the object. 4. Resolve any forces at an angle into x and y components. 5. Write an equation for both the x and y directions in the form of 6. Determine if the problem is an equilibrium problem. If the object is not accelerating, all forces will sum to zero. 7. Fill in what you know and solve for unknowns. You may have more than one unknown and may need to solve a system of equations. 8. Ask yourself if the answer makes sense in terms of the number’s and sign (+ or -). 9. Check your units!   **Multiple Objects**   1. Draw a free body diagram for each object. 2. Apply Newton’s 3rd Law to account for all action/reaction force pairs. 3. Follow the general procedure.   **Inclined Planes**   1. In general, it is more convenient to rotate the coordinate system to line up with the inclined plane. 2. Resolve the gravitational force (mg) into a normal (mg cosθ) and perpendicular (mg sinθ) components. 3. Determine if there are any frictional forces. If there are, they will be acting against the motion; resisting the motion of the object. 4. Write Newton’s 2nd Law equations for both the x and y directions and solve for the unknown(s).   **Elevators**   1. acar = 0: Apparent weight = mg 2. acar = up (+): Apparent weight = m(g+a) 3. acar = down (-): Apparent weight = m(g+(-a)) 4. acar = -g (free fall): Apparent weight = 0 |  |